

# **Iowa Department of Natural Resources**

## **Checklist for Bridge Project Applications**

In order for this project to be reviewed in the shortest time possible, we ask that you make certain that the following items are included with your bridge application

- ☐ Completed and Signed Application
- ☐ IDOT Form 1E (if applicable)
  - ☐ 2-Sets of Design Plans (full size) Containing the Following:
    - ☐ Survey Datum Reference
    - ☐ North Arrow
    - ☐ Site Map
    - ☐ Pier Width
    - ☐ Elevation of Low Chord
    - ☐ Elevation of Low Point in Approach Grade
    - ☐ Existing Bridge Data (if applicable)
- ☐ Hydrologic Calculations (50 yr. & 100 yr. floods)
- ☐ Hydraulic Calculations, Including the Following (where applicable):
  - ☐ Plotted Valley Cross-Section (for Hydraulic Design Series 1 Review)
  - ☐ Map Showing Location of All Valley Cross-Sections Used
  - ☐ Summary of Hydraulic Calculations, Including Stream Slope, Velocity, Backwater and Freeboard for 50 yr. and 100 yr. flows.
  - ☐ Hard copy of all hydraulic models (for HECRAS, DOT Bridge Backwater, etc.)
  - ☐ Disk with copy of all hydraulic models (for HECRAS, DOT Bridge Backwater, etc.)
- ☐ Variance Request Letter (if applicable)

Date: \_\_\_\_\_  
Completed By: \_\_\_\_\_

## Bridge Analysis Guide

1. **Application:** Completed and Signed Joint Application Form Submitted? Yes \_\_\_\_\_ No \_\_\_\_\_

Applicant Name: \_\_\_\_\_

Location: \_\_\_\_\_ Sec \_\_\_\_\_, T \_\_\_\_\_ N, R \_\_\_\_\_, County: \_\_\_\_\_

Stream(s): \_\_\_\_\_

## 2. When Permit Required:

**567—71.1 (455B) Bridges, culverts, temporary stream crossings, and road embankments.** Approval by the department for the construction, operation, and maintenance of bridges, culverts, temporary stream crossings, and road embankments shall be required in the following instances.

**71.1(1) Rural area—floodway.** In rural areas, bridges, culverts, road embankments, and temporary stream crossings in or on the floodway of any river or stream draining more than 100 square miles. (NOTE: Channel modifications associated with bridge, culvert or roadway projects may need approval; see 567—71.2(455B).)

**71.1(2) Rural area—floodway and flood plain.** Road embankments located in the floodway or flood plains, but not crossing the channel of a river or stream draining more than 10 square miles, where such works occupy more than 3 percent of the cross-sectional area of the channel at bankfull stage or where such works obstruct more than 15 percent of the total cross-sectional area of the flood plain at any stage. In determining a 15 percent occupancy of the flood plain, the concept of equal and opposite conveyance as defined in 567—Chapter 70 shall apply.

**71.1(3) Urban areas.** In urban areas, bridges, culverts, road embankments and temporary stream crossings in or on the floodway or flood plains of any river or stream draining more than 2 square miles.

**567—71.2 (455B) Channel changes.** Approval by the department for the construction, operation, and maintenance of channel changes shall be required in the following instances.

**71.2(1) Rural areas.** In rural areas:

b. Channel changes associated with road projects in or on the floodway of any stream draining more than 10 square miles at the location of the channel change whereby either (i) more than a 500-foot length of the existing channel is being altered or (ii) the length of existing channel being altered is reduced by more than 25 percent.

**71.2(2) Urban areas.** In urban areas channel changes on any river or stream draining more than 2 square miles at the location of the channel change.

Located within a Corporate Limits? Yes \_\_\_\_\_ No \_\_\_\_\_

Drainage Area: \_\_\_\_\_ Approval Needed? Yes \_\_\_\_\_ No \_\_\_\_\_

Channel Change Involved? Yes \_\_\_\_\_ No \_\_\_\_\_

Channel Change >500 ft or reduces length by more than 25%? Yes \_\_\_\_\_ No \_\_\_\_\_

**3. Engineering Plans:** 2 Sets of Certified Plans Submitted? Yes \_\_\_\_\_ No \_\_\_\_\_

Location Map Included? Yes \_\_\_\_\_ No \_\_\_\_\_ (*Quad Maps Available at <http://ortho.gis.iastate.edu/>*)

Site Map Included? Yes \_\_\_\_\_ No \_\_\_\_\_

Survey Datum: \_\_\_\_\_ (NGVD, other, explain)

Typical Stream Width: \_\_\_\_\_ Typical Flood Plain Width: \_\_\_\_\_

Channel Bottom Elevation: \_\_\_\_\_ Average Flood Plain Elevation: \_\_\_\_\_

Record High Water Elevation: \_\_\_\_\_ Date: \_\_\_\_\_

Existing Bridge Length: \_\_\_\_\_ Proposed Bridge Length: \_\_\_\_\_

Bridge Skew (Degrees): Bridge to Stream: \_\_\_\_\_

Piers to Stream: \_\_\_\_\_

Abutments to Stream: \_\_\_\_\_

Low Steel (Chord) Elevation: At Right Abutment \_\_\_\_\_

At Left Abutment \_\_\_\_\_

At Mid Span \_\_\_\_\_

Abutment Berm Elevation: Left \_\_\_\_\_ Right \_\_\_\_\_ Side Slopes: \_\_\_\_\_

Pier Width: \_\_\_\_\_ Pier Type (T-Pier, Pile Bent, other): \_\_\_\_\_

Extent of Roadgrade Change (length, elevation, etc.): \_\_\_\_\_

Channel Excavation for Transition (expansion/contraction)? Yes \_\_\_\_\_ No \_\_\_\_\_

Explain: \_\_\_\_\_

**4. Hydraulics & Hydrology:**

Does Community Have a Detailed Flood Insurance Study (FIS)? Yes \_\_\_\_\_ No \_\_\_\_\_ (*If "Yes" continue with Section 4.a. If "No", Skip to Section 4.b, for the situation where No Detailed FIS Exists for The Stream*)

**a.** If "Yes", Does Study Include Detailed Information (Floodway and 100 yr. Flood) Information For this Stream? Yes \_\_\_\_\_ No \_\_\_\_\_ (*If "No", Skip to Section 4.b, for the situation where No Detailed FIS Exists for The Stream*).

Was Original Hydraulic Model Obtained From FEMA Library? (*For instructions on how to order study data from the FEMA Library, see [http://www.fema.gov/plan/prevent/fhm/st\\_order.shtml](http://www.fema.gov/plan/prevent/fhm/st_order.shtml)*) Yes \_\_\_\_ No \_\_\_\_

If "No", Explain: \_\_\_\_\_

If "No", What is Source of Information? \_\_\_\_\_

\_\_\_\_\_

When analyzing the effects of a new or replacement bridge where a detailed Flood Insurance Study (FIS) exists, the following series of hydraulic models should normally be performed in the specified order to create a "Base" condition. Please Check that these runs were done in the order listed:

Step #1) Original Hydraulic Model As Received From FEMA. \_\_\_\_\_

Step #2) Original Hydraulic Model With Corrections Made. \_\_\_\_\_

Step #3) Corrected Model With Additional Cross-Sections Located At The Project Site. \_\_\_\_\_  
(Modeling for a "new" bridge will require inserting cross-sections immediately upstream and downstream of the proposed bridge location. Models for replacement bridges will likely not require additional cross-sections as they should be in the original model obtained from FEMA.)

Step #4) Model from Step #3 with the new or replacement bridge included. \_\_\_\_\_

The model resulting from Step #3 will be the "base" condition and will be used to determine the effects of the bridge on flood stages (e.g., backwater). (Note: The hydraulic models specified above are the minimum needed to analyze the effects of the bridge on flood stages. Additional modeling may be required.)

Have all of the referenced hydraulic models been submitted on disk? Yes \_\_\_\_\_ No \_\_\_\_\_

After completion of the Above Section, Skip to the "Summary" Section on Page 4

**b. If No Detailed FIS Exists for This Stream**

Hydrology: 50 year Flood Discharge \_\_\_\_\_ 100 Year Flood Discharge \_\_\_\_\_

Source of Discharge Information (Check One):

\_\_\_\_ USGS Regional Equations Report 87-4732

\_\_\_\_ USGS Regional Equations Report 00-4233

\_\_\_\_ Corps Study

\_\_\_\_ WRC 17B analysis of Gage Data

\_\_\_\_ Nearby Flood Insurance Study

\_\_\_\_ Other (Explain) \_\_\_\_\_

Stream Slope: \_\_\_\_\_ ft/ft

\_\_\_\_\_ ft/mi Source (topo map, \*survey, other): \_\_\_\_\_

\*(Note: If surveyed profile is used to determine stream slope, the length should be sufficient so as to be representative of the typical stream slope.)

Method of Backwater Analysis(Check One):

\_\_\_\_ HECRAS/HEC2 (Disk with Input/Output Included? Yes \_\_\_\_ No \_\_\_\_ )

\_\_\_\_ WSPRO (Disk with Input/Output Included? Yes \_\_\_\_ No \_\_\_\_ )

\_\_\_\_ DOT Bridge Backwater (Disk with Input/Output Included? Yes \_\_\_\_ No \_\_\_\_ )

\_\_\_\_ Federal Highway Administration Hydraulic Design Series 1 (See Worksheet Page 7)

Surveyed Valley Cross-Section Included (Full Valley Section Required)? Yes \_\_\_\_ No \_\_\_\_

Site Plan Showing Location of Cross-Section Included? Yes \_\_\_\_ No \_\_\_\_

Rating Curve Included? Yes \_\_\_\_ No \_\_\_\_

Backwater Calculations Included? Yes \_\_\_\_ No \_\_\_\_

Mannings “n” Value Used:

Channel \_\_\_\_\_ Left Overbank \_\_\_\_\_ Right Overbank \_\_\_\_\_

(Typical “n” Values are listed on Page 6)

Photographs Included to Verify “n” Values? Yes \_\_\_\_ No \_\_\_\_

Upstream Damage Potential: \_\_\_\_\_

Field Verified? Yes \_\_\_\_ No \_\_\_\_

## 5. Summary:

	50 yr. Flood	100 yr. Flood
Discharge (cfs)	_____	_____
Water Surface Elev.	_____	_____
Backwater	_____	_____
*Velocity	_____	_____
Freeboard	_____	_____
Waterway Opening (sq. ft.)	_____	_____
Road Grade Overflow (cfs)	_____	_____

\*Are Velocities Excessive? Yes \_\_\_\_ No \_\_\_\_\_. If “Yes”, What Stabilization Methods are Being Used? \_\_\_\_\_

## 6. Approval:

DNR Approval Criteria:

**567—72.1 (455B) Bridges and road embankments.** The following criteria shall apply to the construction, operation, and maintenance of bridges and road embankments.

**72.1(1) Bridges and road embankments affecting low damage potential areas.** For bridges and road embankments affecting floodway or flood plain areas having a low flood damage potential, the following criteria will apply:

- Backwater Q50. The maximum allowable backwater for Q50 and lesser floods is limited to 0.75 foot.
- Backwater Q100. The maximum allowable backwater for Q100 is limited to 1.5 feet.
- Freeboard. The minimum freeboard for low superstructure horizontal bridge members above Q50 is 3 feet.

Does Bridge Project Satisfy Criteria? Yes \_\_\_\_ No \_\_\_\_

Variance Requested? Yes \_\_\_\_ No \_\_\_\_

For (Check Appropriate Items): Freeboard \_\_\_\_ Backwater \_\_\_\_

NFIP “No-Rise” Certification Criteria:

On a stream with a detailed FIS, FEMA requires that the new or replacement bridge will result in “no-rise” (i.e., 0.00 ft. increase) in the 100 year flood profile when compared to the “base condition” model (see modeling process previously outlined in Section 4.a.). A certification of “no-rise” should be included in with the application.

## 7. Variance:

### Criteria For Variance:

567— 72.31 (455B) Variance.

**72.31(1)** *In general. Where evidence is presented that additional private or significant public damage will not result from flood plain or floodway construction (other than channel changes) subject to regulation under 567—Chapters 70 to 72, the department may permit variance to the criteria stated in Chapter 72.*

### Possible Justifications For Variance:

- Grade Constraints
- Easements Obtained for Areas Affected By Backwater
- Low Potential for Debris and Ice Accumulation
- Bridge Designed to Withstand Inundation
- Substantial Roadgrade Overflow

If variance is requested, explain justification for request: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Note: A variance request should be made by letter and should include the above reference justification and explanation.

## 8. Out of Order Processing Requested:

### Criteria for Out of Order Processing:

**567—70.5(2) (455B)** *Order of processing. In general, complete applications including sufficient plans and specifications shall be reviewed in the order that complete information is received. However, when there are a large number of pending applications, which preclude the department from promptly processing all applications, the department may expedite review of a particular application out of order if the completed application and supporting documents were submitted at the earliest practicable time and any of the following conditions exist:*

- a. *Relatively little staff review time (generally less than four hours) is required and delay will cause the applicant hardship;*
- b. *The applicant can demonstrate that a delay in the permit will result in a substantial cost increase of a large project;*
- c. *Prompt review of the permit would result in earlier completion of a project that conveys a significant public benefit;*
- d. *The need for a permit is the result of an unforeseen emergency or catastrophic event; or*
- e. *A permit is needed to complete a project that will abate or prevent an imminent threat to the public health and welfare*

Request Made for Out of Order Processing? Yes \_\_\_\_ No \_\_\_\_

If “Yes”, basis for request: \_\_\_\_\_  
\_\_\_\_\_

## Typical Mannings “n” Coefficients for Natural Stream Valleys

### Channel

#### Small to medium drainage areas

Irregular section, meandering channel, rocky or rough bottom, medium to heavy growth on bank and side slopes.	0.04 – 0.05
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Uniform section, relatively straight, Smooth earthen bottom, medium to Light growth on bank and side slopes.	0.03 – 0.04
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Large drainage area	0.025 – 0.035
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### Overbank Flood Plain Areas

#### Pasture land

No brush or trees	0.05 – 0.07
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Light brush and trees	0.06 – 0.08
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Crop Land	0.07 – 0.09
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#### Brush and Trees

Heavy weeds, scattered brush	0.08 – 0.10
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Medium to dense brush and trees	0.09 – 0.12
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Dense Brush and Trees	0.10 – 0.15
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Heavy stand of timber, a few downed trees, little undergrowth	0.07 – 0.10
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**THE FOLLOWING WORKSHEET NEEDED ONLY WHEN DOING CALCULATIONS BY HAND**

**Federal Highway Administration  
Hydraulic Design Series No. 1  
Bridge Backwater Analysis**

Flood Frequency Data

50 yr. , _____ cfs	100 yr. , _____ cfs
Stage , _____ ft.	Stage , _____ ft.
Velocity , _____ fps	Velocity , _____ fps
Alpha ( $\alpha_1$ ) , _____	Alpha( $\alpha_1$ ) , _____

Skew

Bridge (relative to stream) \_\_\_\_\_ degrees

Piers (relative to stream) \_\_\_\_\_ degrees

	<u>50 yr. Flood</u>	<u>100 yr. Flood</u>
Bridge opening characteristics (sq. ft.) $A_{n2}$ =	_____	_____
Skew Adjusted $A_{n2}$ =	_____	_____
Roadgrade Overflow (if applicable) cfs.	_____	_____
a) $Q = CLH^{3/2} =$ $C = 2.7 \text{ to } 3.1$ $L = \text{Length of weir}$ $H = \text{Head}$	$= \frac{\text{_____}}{(C)} \frac{\text{_____}}{(L)} \frac{\text{_____}}{(H)}^{3/2}$ $= \text{_____}$	$= \frac{\text{_____}}{(C)} \frac{\text{_____}}{(L)} \frac{\text{_____}}{(H)}^{3/2}$ $= \text{_____}$
B Width (ft.) (See Page 9 Attached)	= _____ = _____	= _____ = _____
$B = \frac{A_{n2}}{Y}$ , Y = depth		
Flow Distribution		
$Q_a =$	_____	_____
$Q_b =$	_____	_____
$Q_c =$	_____	_____
$M = \frac{Q_b}{Q_{Total}}$	= _____ = _____	= _____ = _____
$K_b =$ (Figure 6, HDS1, Page 10 Attached)	_____	_____



$$J = \frac{\text{Area of Piers}}{A_{n2}}$$

= \_\_\_\_\_ = \_\_\_\_\_

= \_\_\_\_\_ = \_\_\_\_\_

$$\Delta K_p = \Delta K (\sigma)$$

(See Fig 7, HDS1, Page 11 Attached)

$$\sigma =$$

$$\Delta K =$$

$$\Delta K_p =$$

$$\text{Skew} = \Delta K_S$$

(See Fig 10, HDS1, Page 14 Attached)

$$\text{Eccentricity} = \Delta K_e$$

(See Fig. 8, HDS1, Page 12 Attached)

$$K^* = K_b + \Delta K_p + \Delta K_S + \Delta K_e$$

$$\text{Velocity (fps)}$$

$$V_{n2} = \frac{Q_{Total}}{A_{n2}}$$

$$\text{Backwater (ft.)}$$

$$h^* = (K^*) (\alpha_2) \frac{V_{n2}^2}{2g}$$

$$= (K^*) (1.5) \frac{V_{n2}^2}{2g}$$

Freeboard

Low Superstructure Elevation

50 year Flood Elevation

Freeboard

**The Following Figures Were Obtained From Federal Highway Administration  
Hydraulic Design Series No. 1 (HDS 1)**

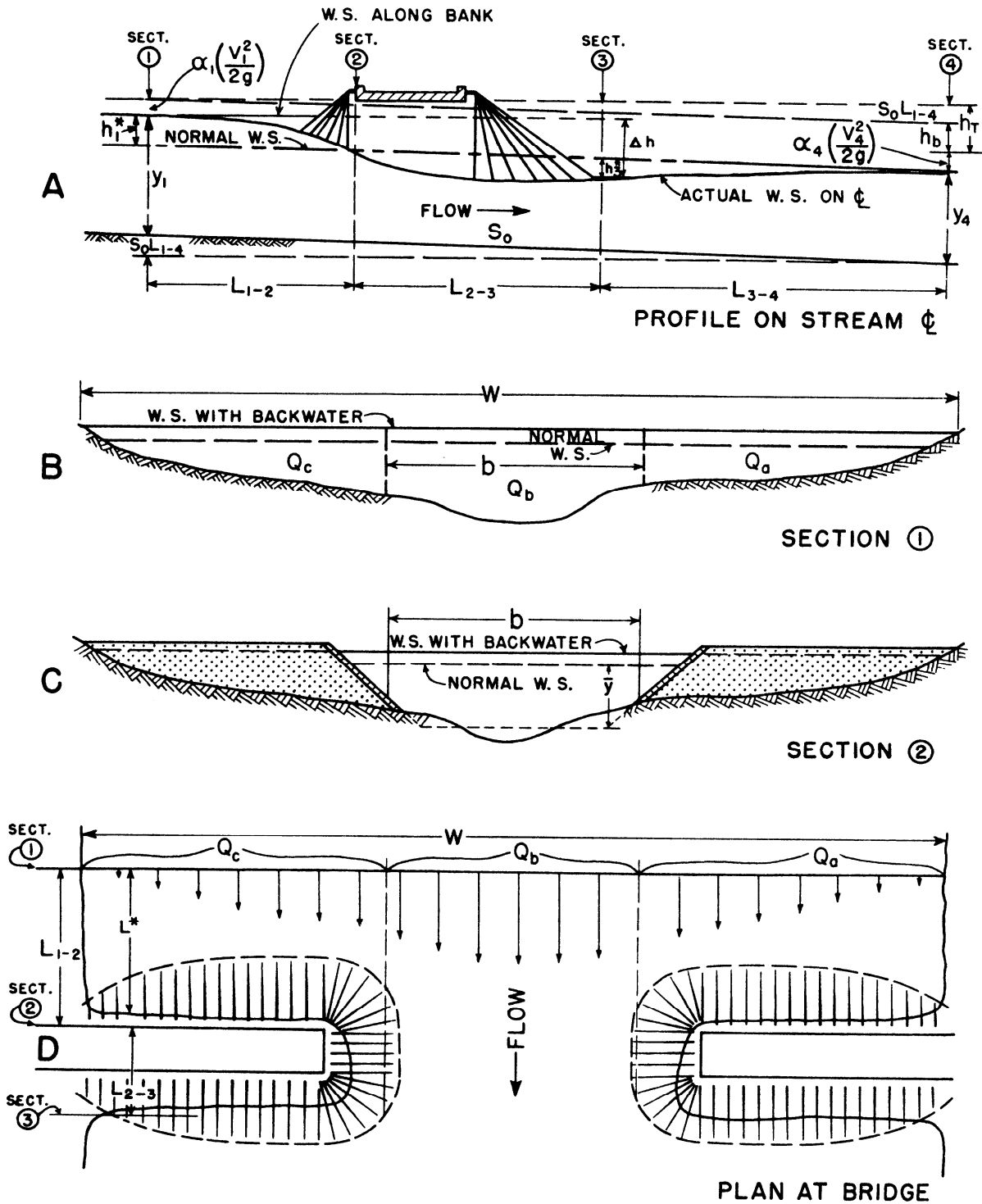


Figure 3.—Normal crossings: Spillthrough abutments.

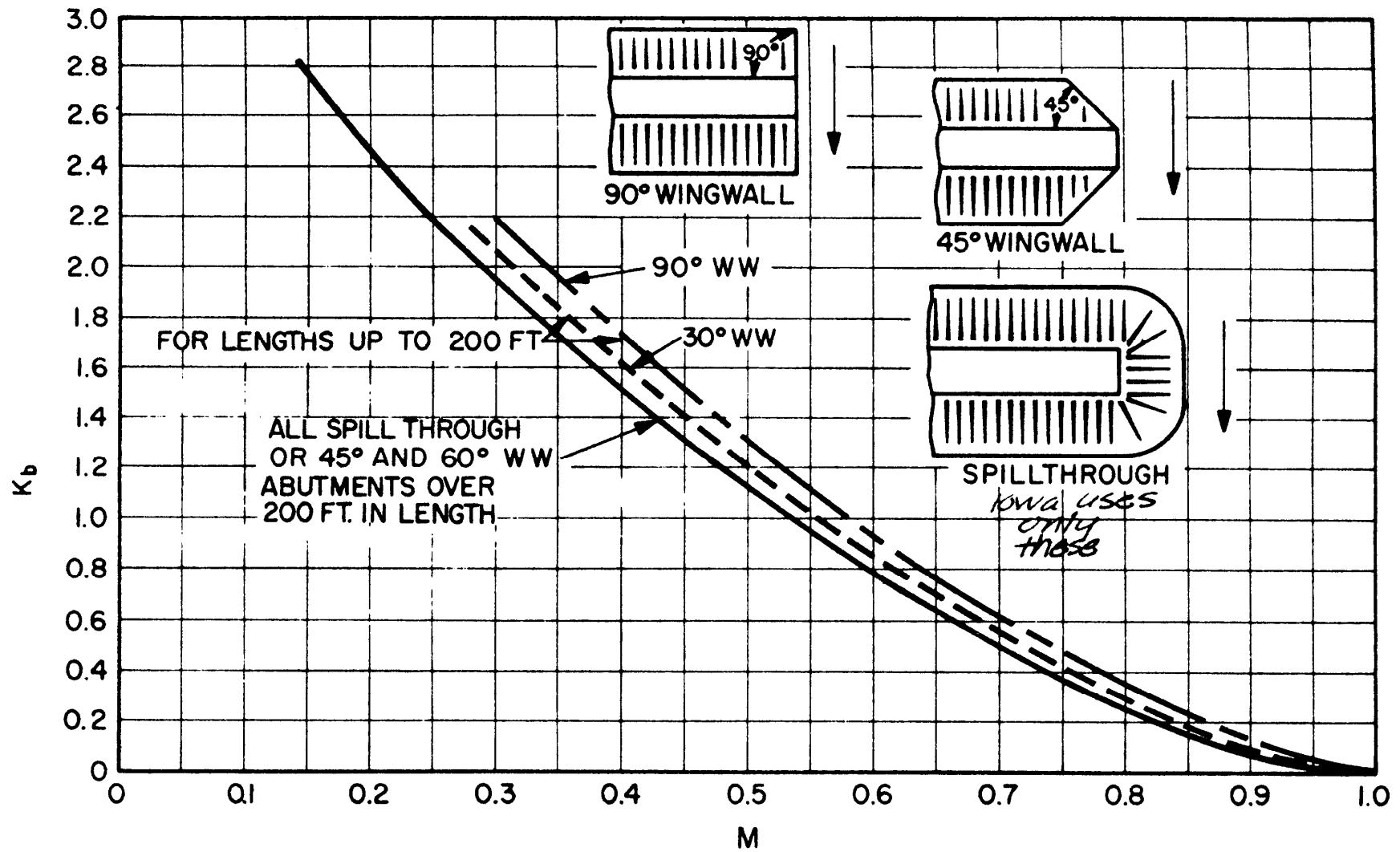
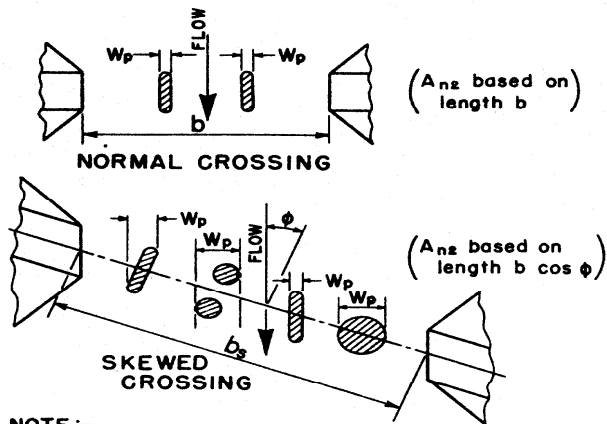


Figure 6.—Backwater coefficient base curves (subcritical flow).



- $W_p$  = Width of pier normal to flow — feet
- $h_{nz}$  = Height of pier exposed to flow — feet
- $N$  = Number of piers
- $A_p = \sum^N W_p h_{nz}$  = total projected area of piers normal to flow — square feet
- $A_{nz}$  = Gross water cross section in constriction based on normal water surface. (Use projected bridge length normal to flow for skew crossings)
- $J = \frac{A_p}{A_{nz}}$

NOTE:— Sway bracing should be included in width of pile bents.

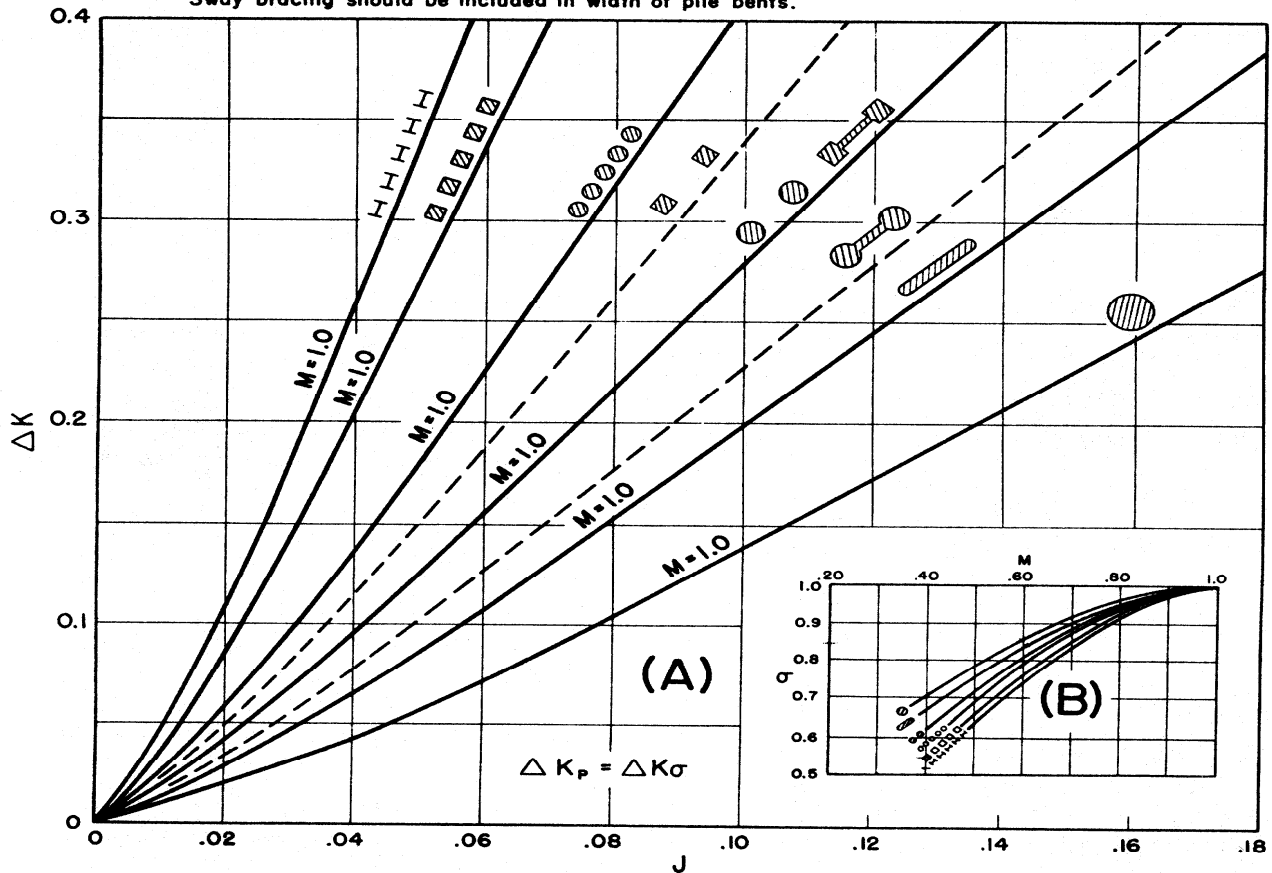


Figure 7.—Incremental backwater coefficient for piers.

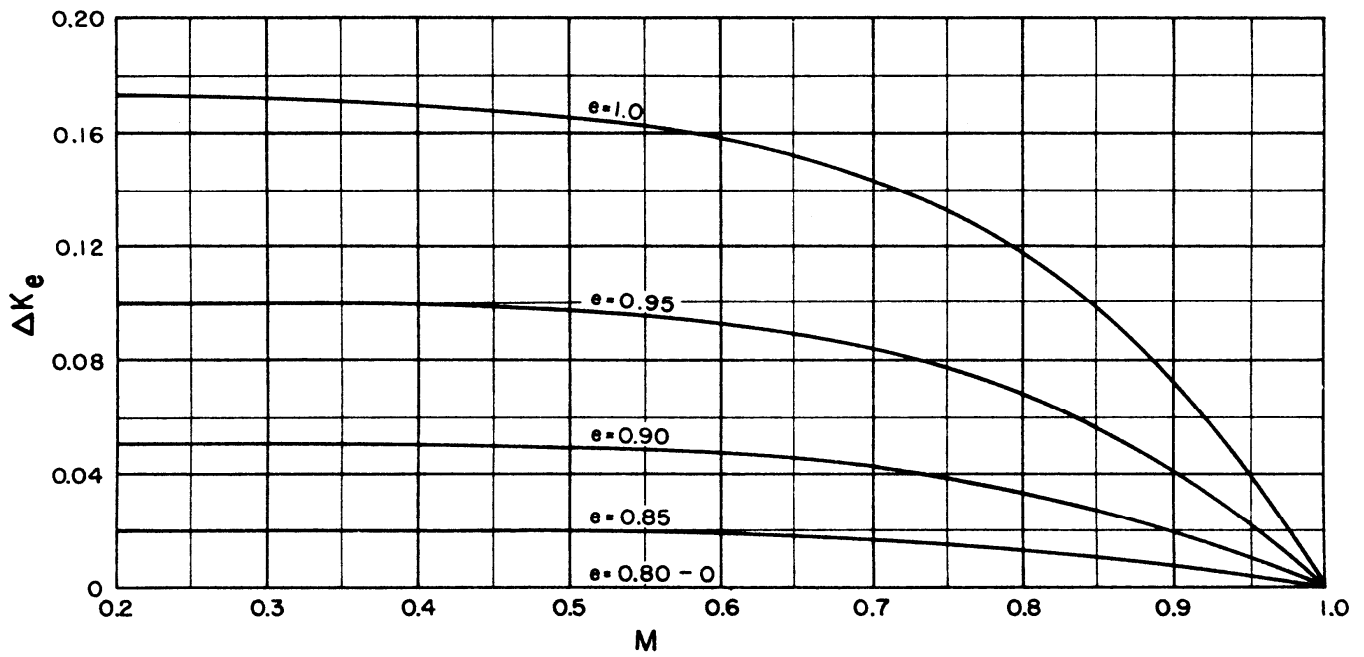
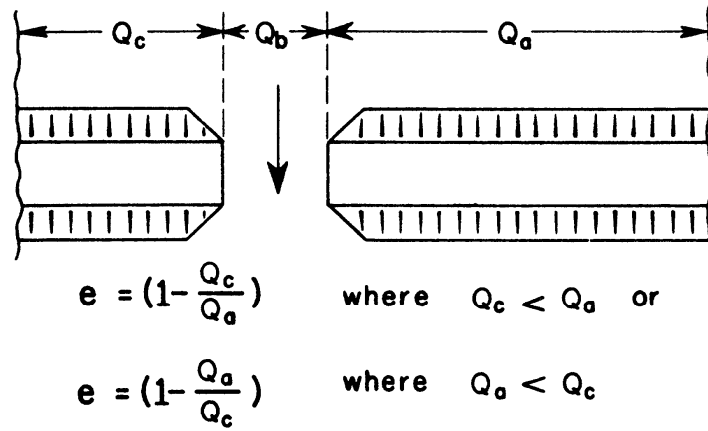


Figure 8.—Incremental backwater coefficient for eccentricity.

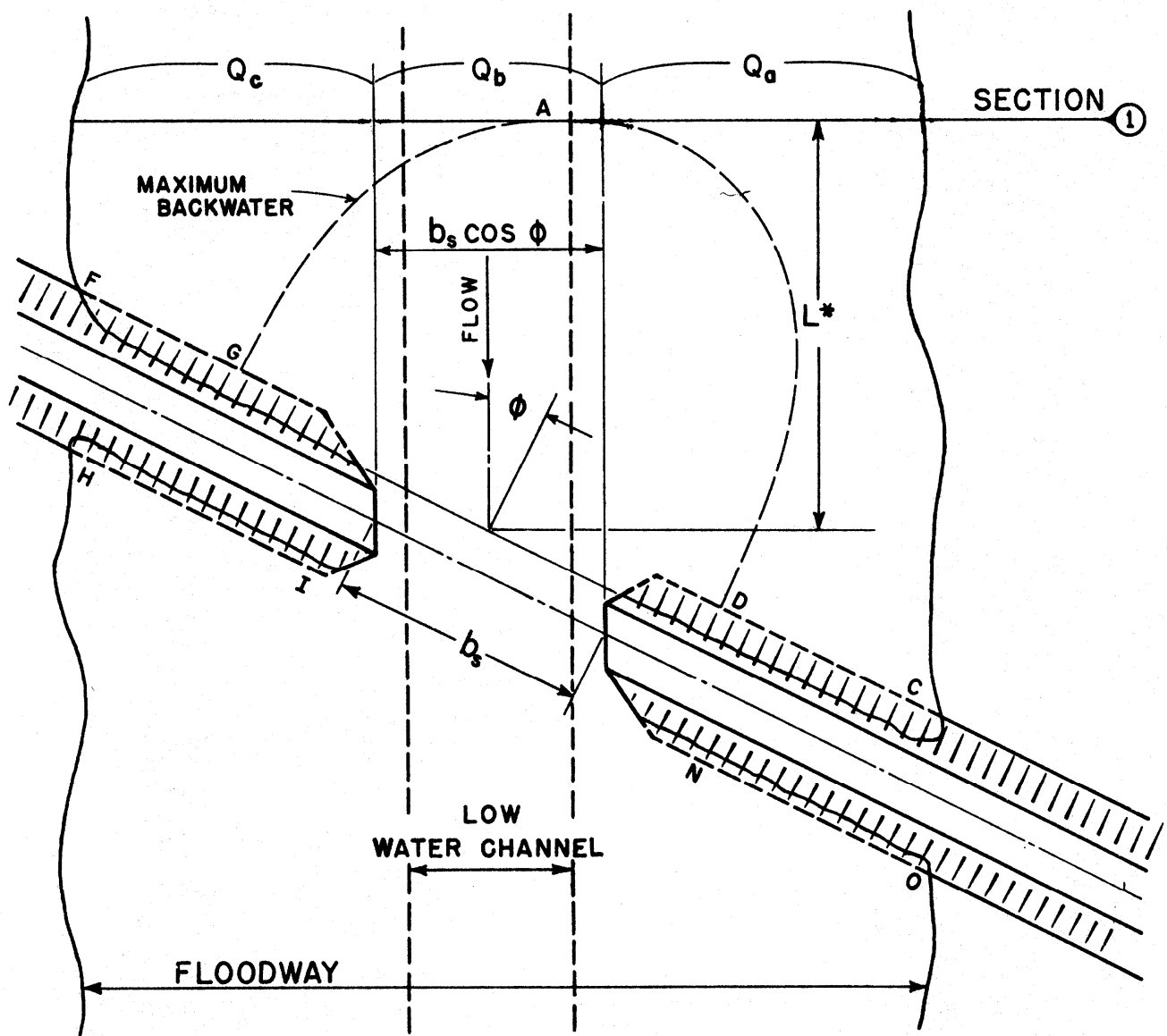


Figure 9.—Skewed crossings.

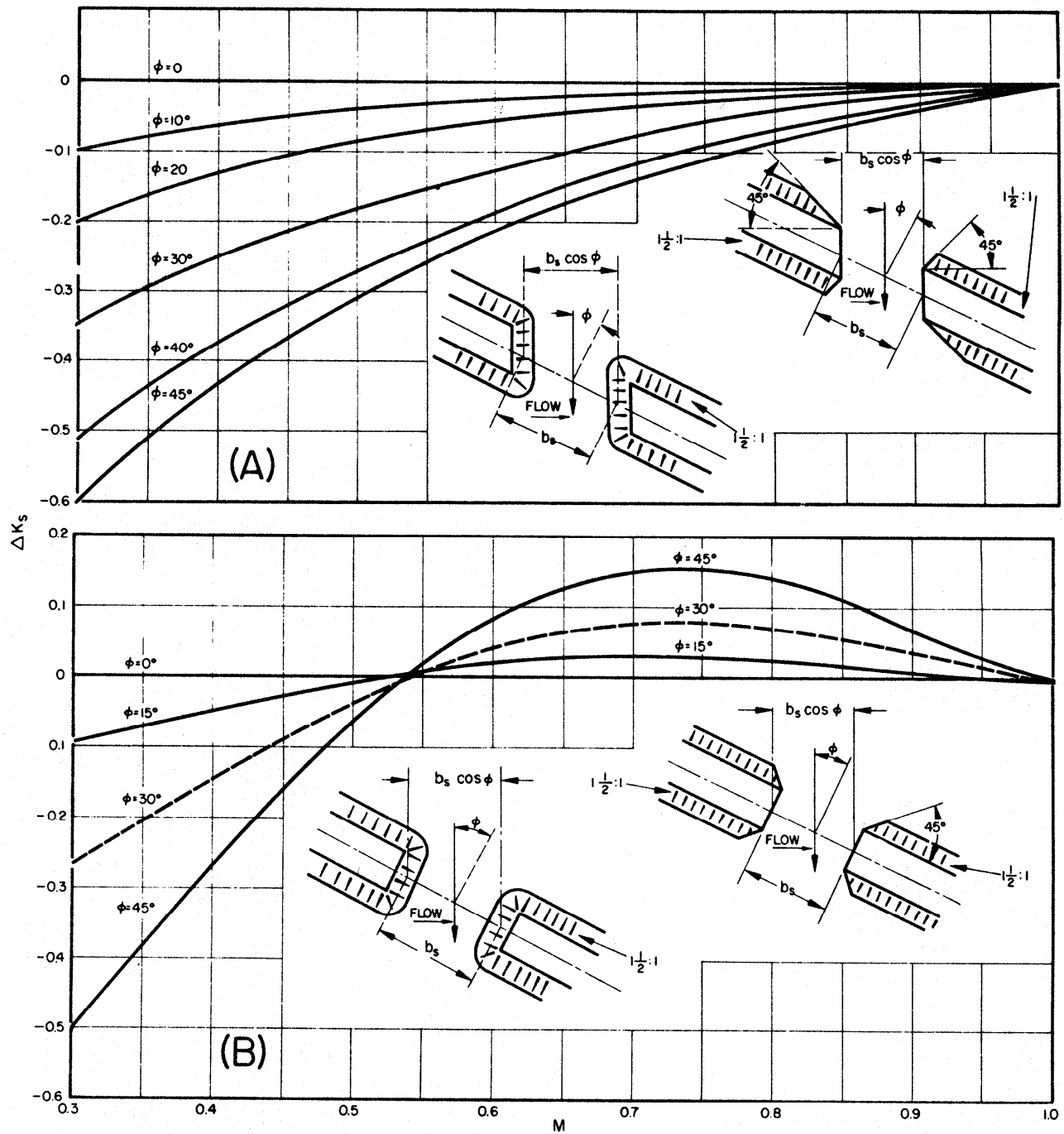


Figure 10.—Incremental backwater coefficient for skew.

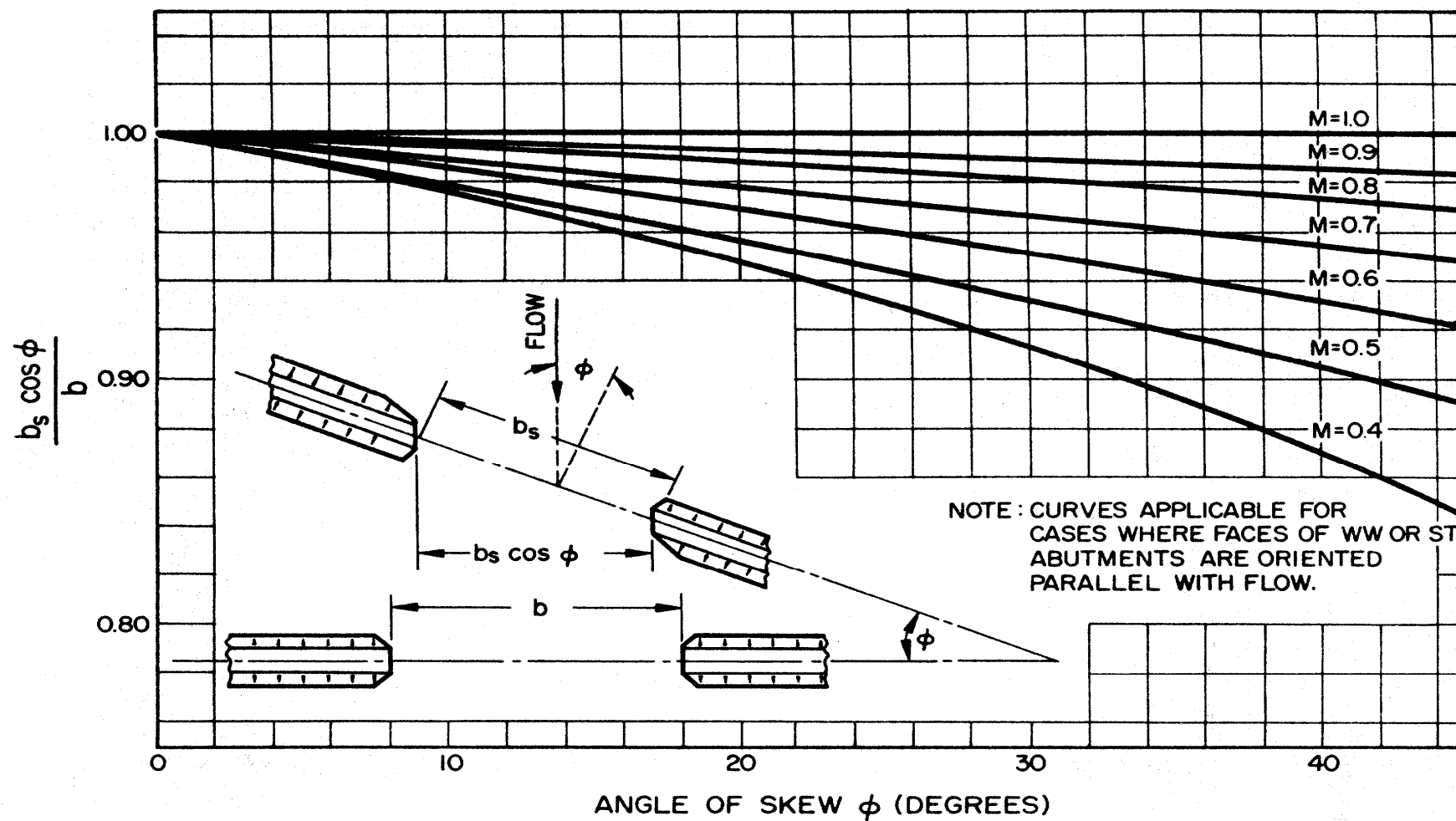


Figure 11.—Ratio of projected to normal length of bridge for equivalent backwater (skewed crossings).